Physics 131
General Physics I
Grinnell College

Homework IV

Session IV.2

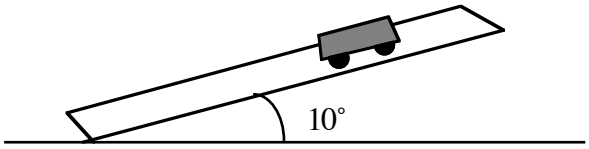
1. One of the nice features of the velocity vs distance formula derived in Unit IV.2 -13 is that it can be used to easily calculate how high an object can be thrown. We learned earlier in the semester that it takes a professional-caliber arm to throw a ball as fast as 50 m/sec. If a ball is thrown straight up at 50 m/sec, how high will the ball go? Use the method of Unit IV.2.

2. I'm going sledding. At the bottom of the hill I travel over level ground, and the snow exerts a force of 200 N on my sled. How much work does that force do on me as I travel 20 m?

3. Continuing on the example in 2, my velocity at the bottom of the hill is 15 m/sec. What is my velocity reduced to after I sled those 20 m? My mass is 70 kg.

Session IV.3

4. In this problem and the next, you will consider a cart rolling down a tilted board. The cart is released from rest at the top of the board, and then rolls down the full length of the 2 m board. The angle between the board and the table is 10°, as shown.



We saw earlier that the component of the gravity force acting down the plane is mgsin(10°). Given this, calculate the acceleration down the board, and from there, the velocity at the end of the board using the techniques of Unit IV, session 2 (Intro to Conservation of Energy).

5. Now, solve problem 4 again using conservation of energy and U=mgh for the gravitational force. First, solve for the vertical distance traveled in the 2 m down the board, and from there use conservation of energy to get the velocity at the bottom. You should get the same answer as you got in 4!

6. A weight is oscillating back and forth on a spring. The spring constant k is 50 N/m, and the weight has mass of 300 g. If it is moving at a velocity of 2 m/sec at the equilibrium (x = 0) position, what is the farthest away from this point that it will move?

7. A 2 kg ball rolling at 5 m/sec bumps into a 1 kg ball which is initially at rest. The 1 kg ball takes off at 15 m/sec, and the 2 kg ball rolls backwards at 2.5 m/sec. Was

momentum conserved in this collision? Was kinetic energy conserved in this collision? Do you think this could easily happen? Explain.

Session IV.4

8. For the following three force rules, decide if energy is conserved or not. If it is, find the corresponding potential energy:

a) $F = -x^3$
b) $F = -v^3$
c) $F = xv$

9. I have an elastic slingshot that can be approximated as a spring. I put a 0.05 kg ball in it and pull it back 0.3 m, and let it go. The ball shoots straight up for a total distance of 25 m.

a) What is the spring constant of the slingshot?
b) What was the maximum force I had to apply to pull the elastic back the full 0.3 m?

10. I am skateboarding along at 5 m/s. A friend ahead of me throws me a 1 kg physics book at –1 m/s. If I weigh 70 kg, how much do I slow down when I catch the book? How much energy is lost in the process?